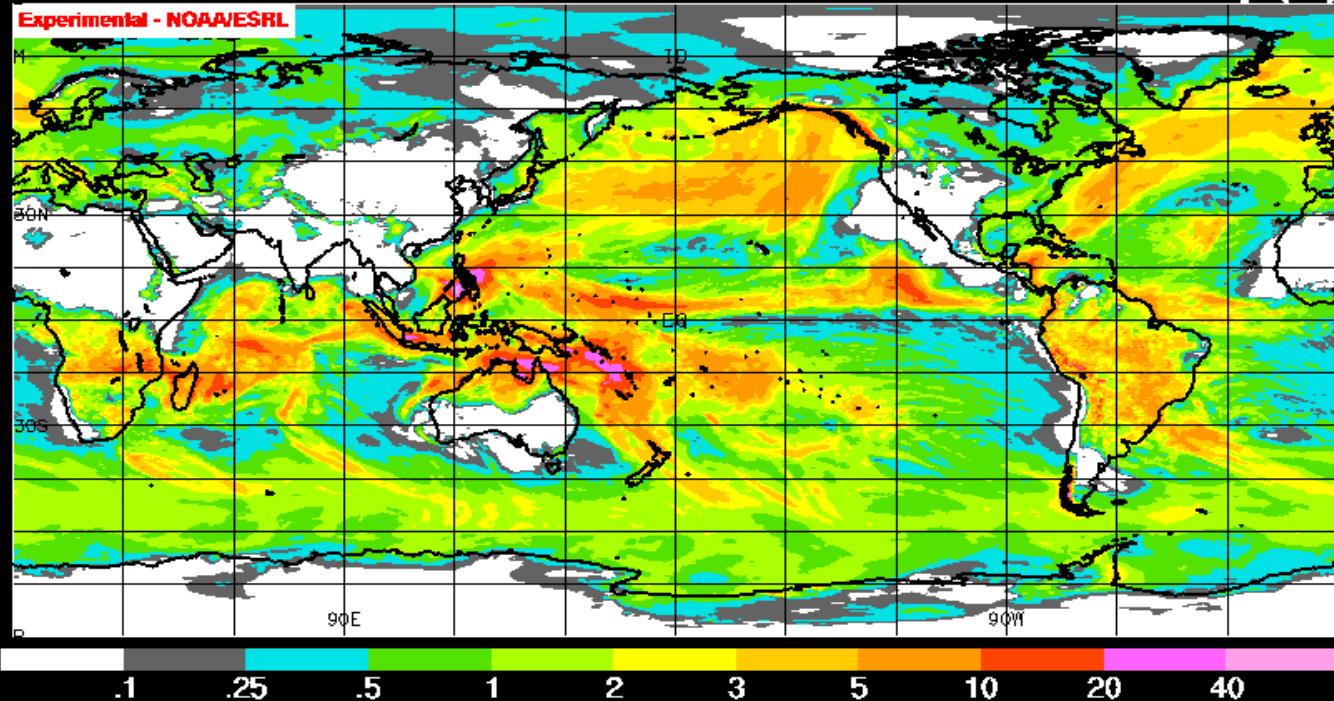


FIM evaluation

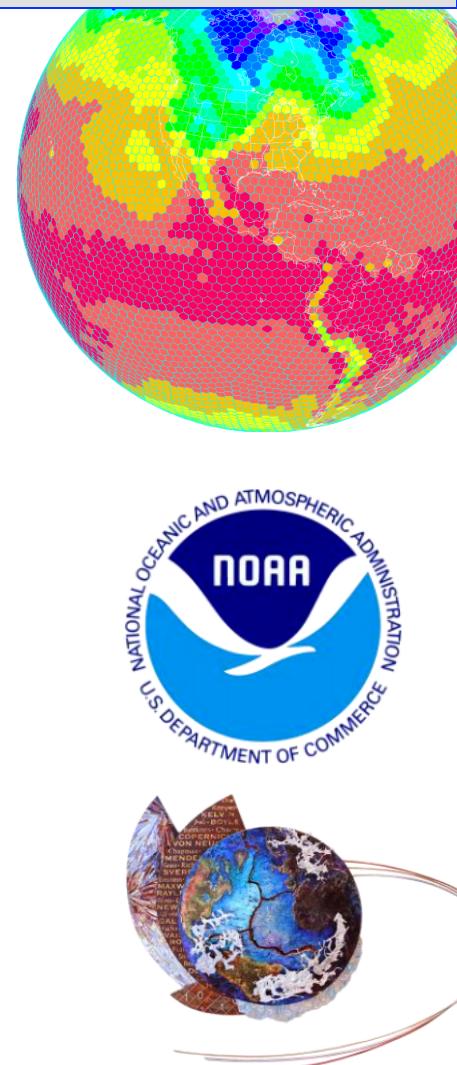
January 2014

EXPER_FIM-9_C01/12/2014 (12:00) 336 hr fcst

Valid 01/26/2014 12:00 UTC
336h Total Precip (in)



15km FIM init 12z 12 Jan 2014



FIM numerical atmospheric model

- Horizontal grid
 - Icosahedral, Arakawa A grid – 60km/30km/15km/10km
- Vertical grid
 - Staggered Lorenz grid, $p_{top} = 0.5 \text{ hPa}$, $\theta_{top} \sim 2200\text{K}$
 - Generalized vertical coordinate
 - Hybrid $\theta-\sigma$ option (64L, options for 100L, 38L, 21L)
 - GFS σ -p option (64 levels)
- Numerics
 - Adams-Bashforth 3rd-order time differencing
 - Flux-corrected transport
- Physics
 - GFS physics suite (May 2011 version), options for Grell-Freitas cu, MYNN PBL, GFS-2012 suite
- Coupled model extension options
 - Chem – WRF-chem/GOCART
 - Ocean – icosahedral HYCOM (no flux coupler), tri-polar HYCOM (with coupler)

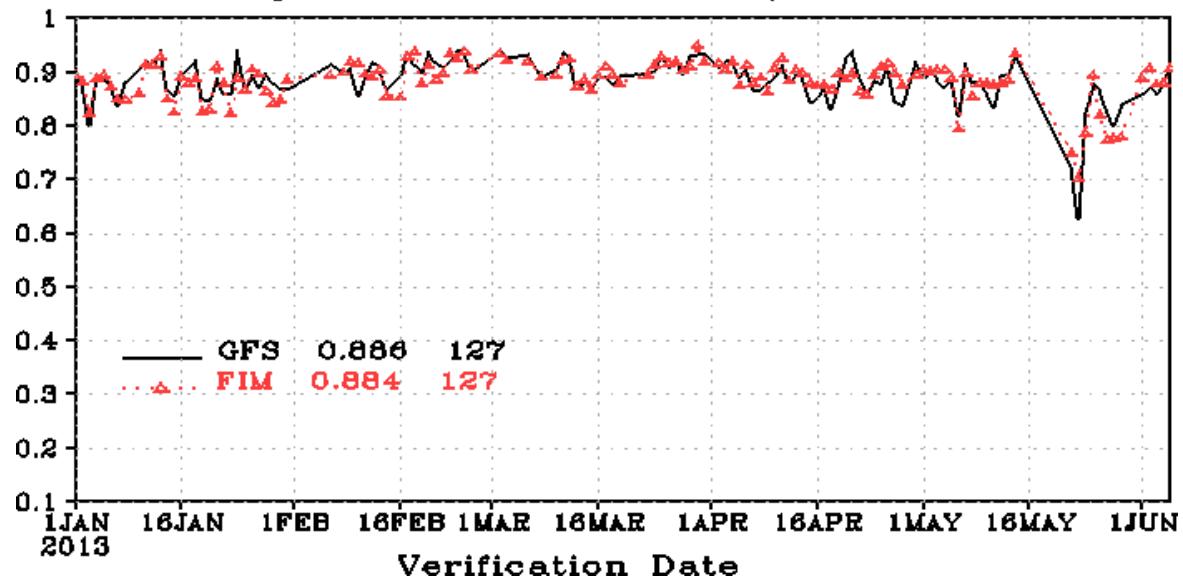
FIM-GFS 1-year comparison

- Period – 1 June 2012 through 30 May 2013
- FIM – initialized from GFS native analyses (sanl/sfcnl), i.e., FIM has not yet been fully cycled
 - ESRL now performing initial experiments with FIM using GSI-EnKF assimilation (Mariusz Pagowski, Jeff Whitaker)
- FIM runs – retrospective for 1 June 2012 through 17 March 2013 (real-time from 17 Mar 13 through May 2013)
 - Subversion r3431
- GFS – real-time runs
- NCEP verification used for analysis/grid verification
 - http://ruc.noaa.gov/vsdb/fim_r3162_pop/
- ESRL verification used for raob verification (0.5 deg data used for both GFS and FIM)

GFS and FIM configurations

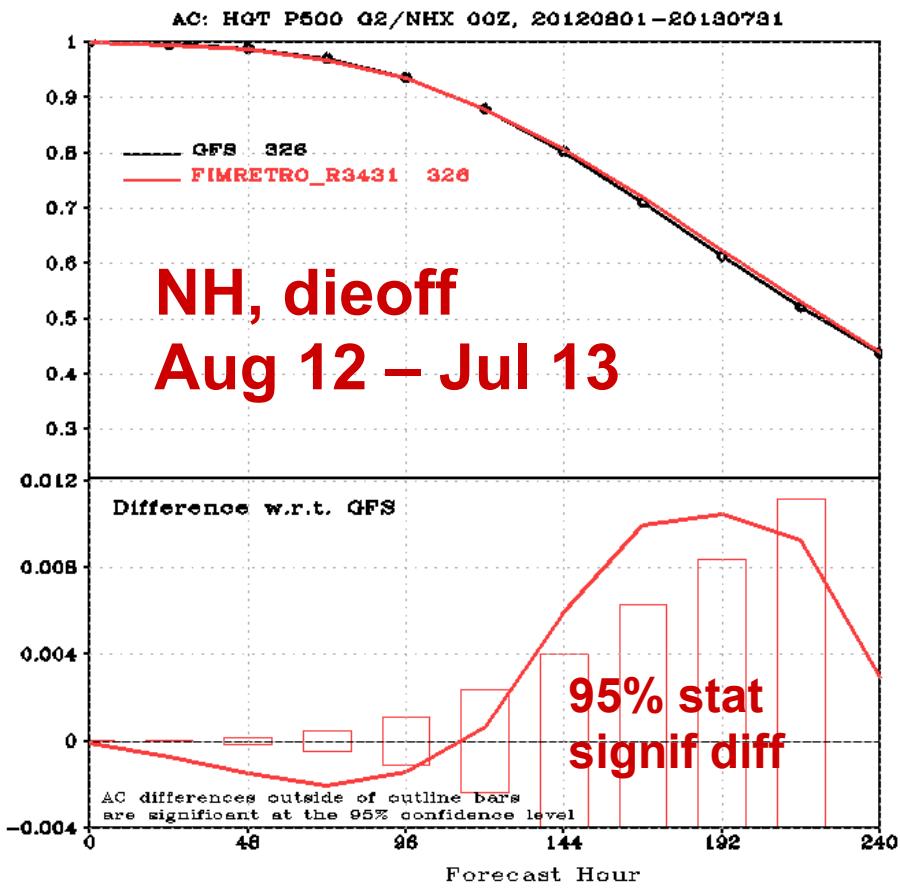
	Horiz resolution	Vertical resolution	Physics	Surface cycling? (SST, land-sfc)	Initialconds	Forward DFI	Terrain elevation, variance (for GWD)	Land-sfc type	Momentum diffusion	Top BC
GFS	T574 spectral	L64, sigma-pres hybrid	May 2012 GFS physics	Yes	GFS IC via GSI/hybrid DA	Y	GFS	GFS	Latest?	
FIM	30km icosahedral	L64 – sigma-isentropic hybrid	May 2011 GFS physics	No	GFS IC (no FIM cycling yet)	N	Elev: Recalculated from USGS global topo Var: GFS	GFS	2 nd -order, diff velocity = 1 m/s (3 m/s near top)	Rayleigh damping, strong with v> 100 m/s

Anomaly Correl: HGT P500 G2/NHX 00Z, fh120

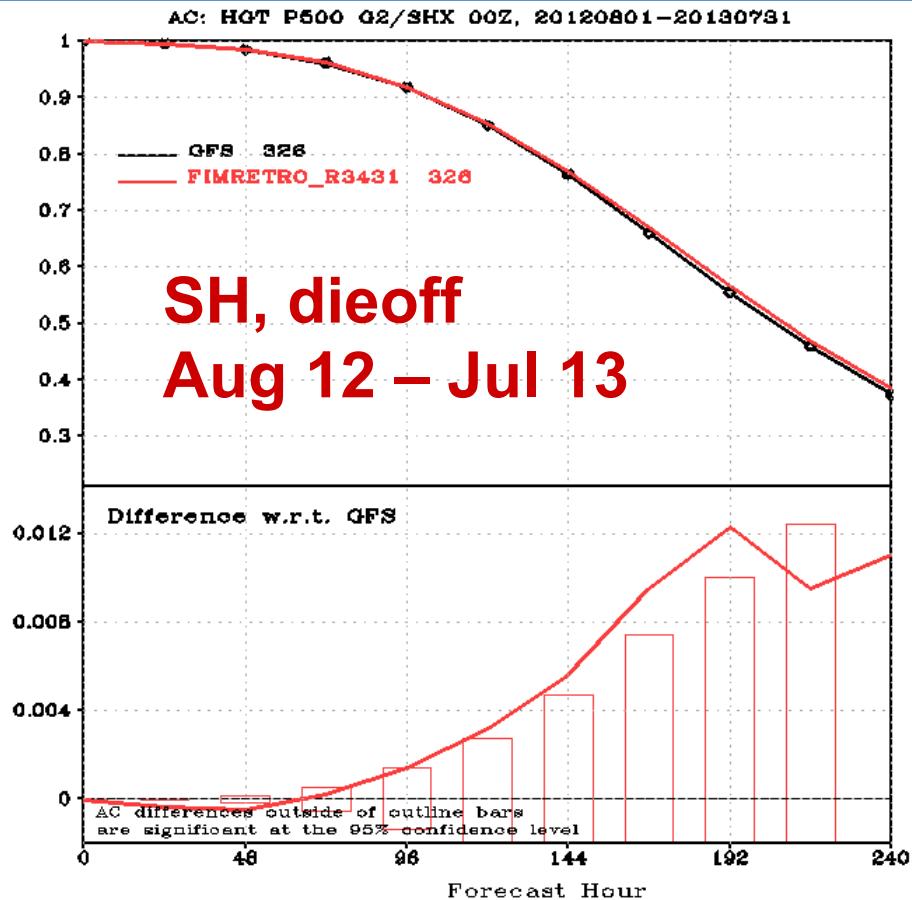


[http://
www.emc.ncep.noaa.gov
/gmb/wx24fy/fim/](http://www.emc.ncep.noaa.gov/gmb/wx24fy/fim/)

500-hPa Height Anomaly Correlation FIM-30km vs. GFS operational



Results from new 12-mo FIM retro - August 2012 through July 2013

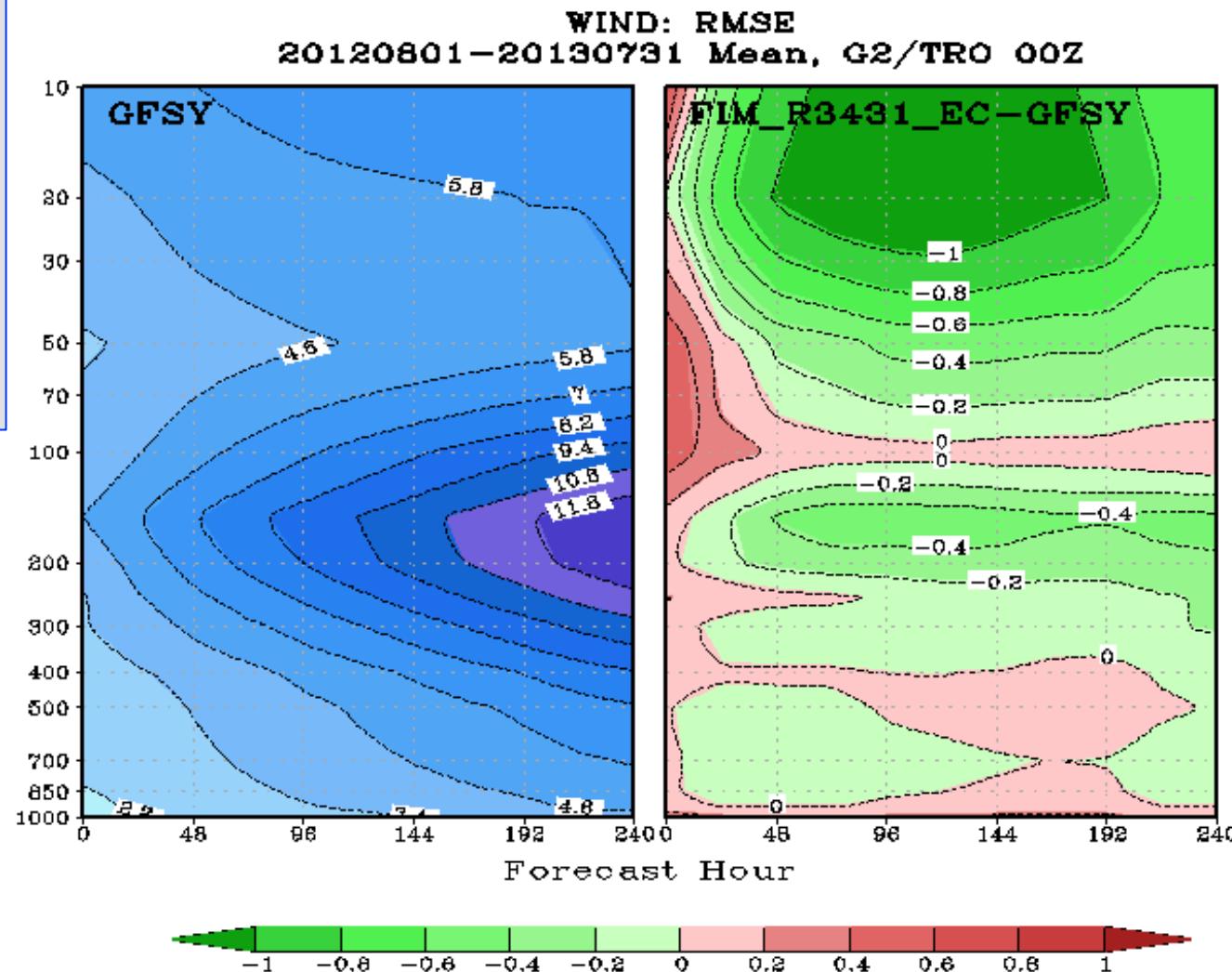


**FIM better skill than GFS for 5+ day duration in N. Hemisphere,
4+ day duration for S. Hemisphere,
statistically significant in both SH and NH**

Vector Wind RMSE – 1-year comparison FIM vs. GFS

Tropics

10-day
forecasts
evaluated
vs.
ECMWF
analysis

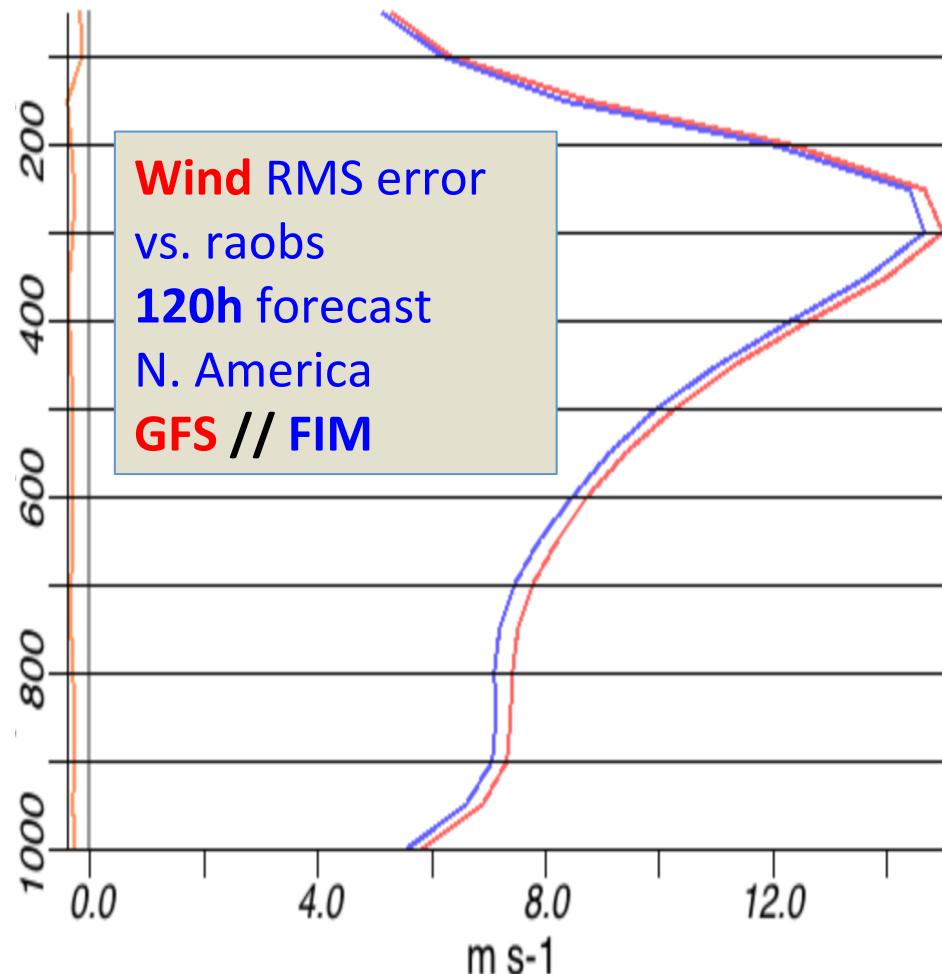
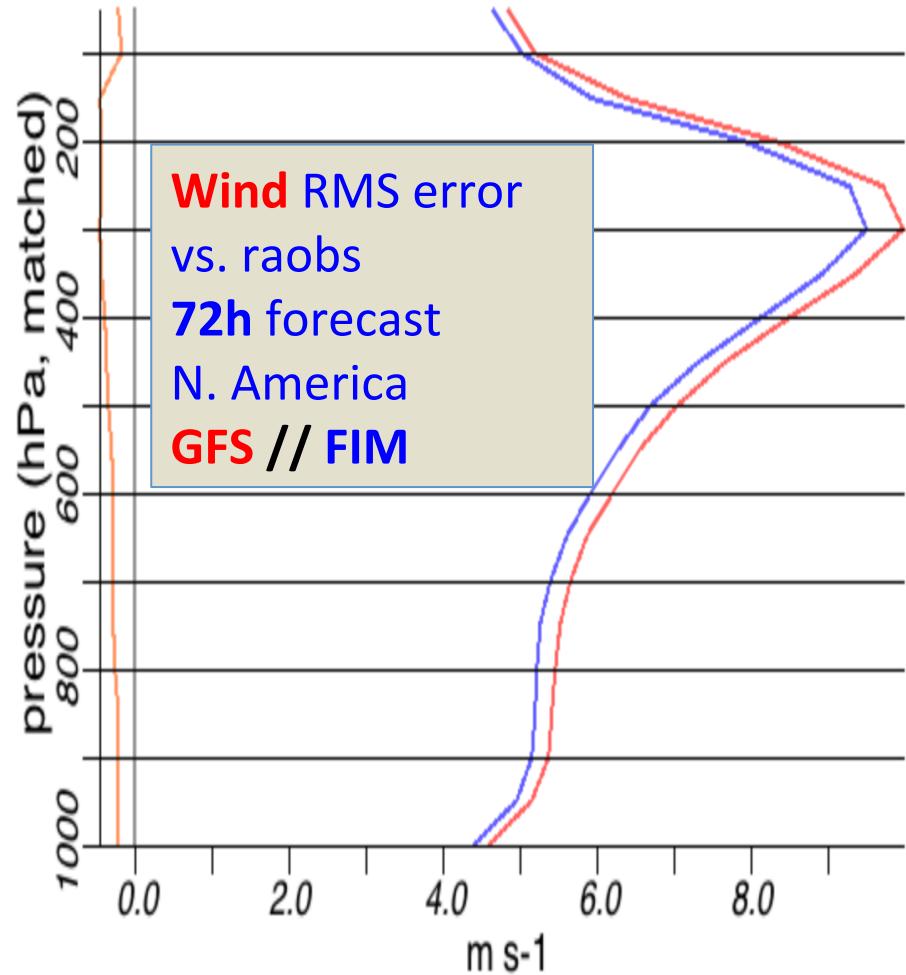


FIM error minus GFS error
Green → FIM error is lower

- **Verification against Upper-Air Rawinsonde Observations –**
 - **12-month period – June 2012 – May 2013**
 - **All raob stations over N. America used**

RMS errors (smaller better) - verification with rawinsonde observations
1-year period – June 2012 through May 2013

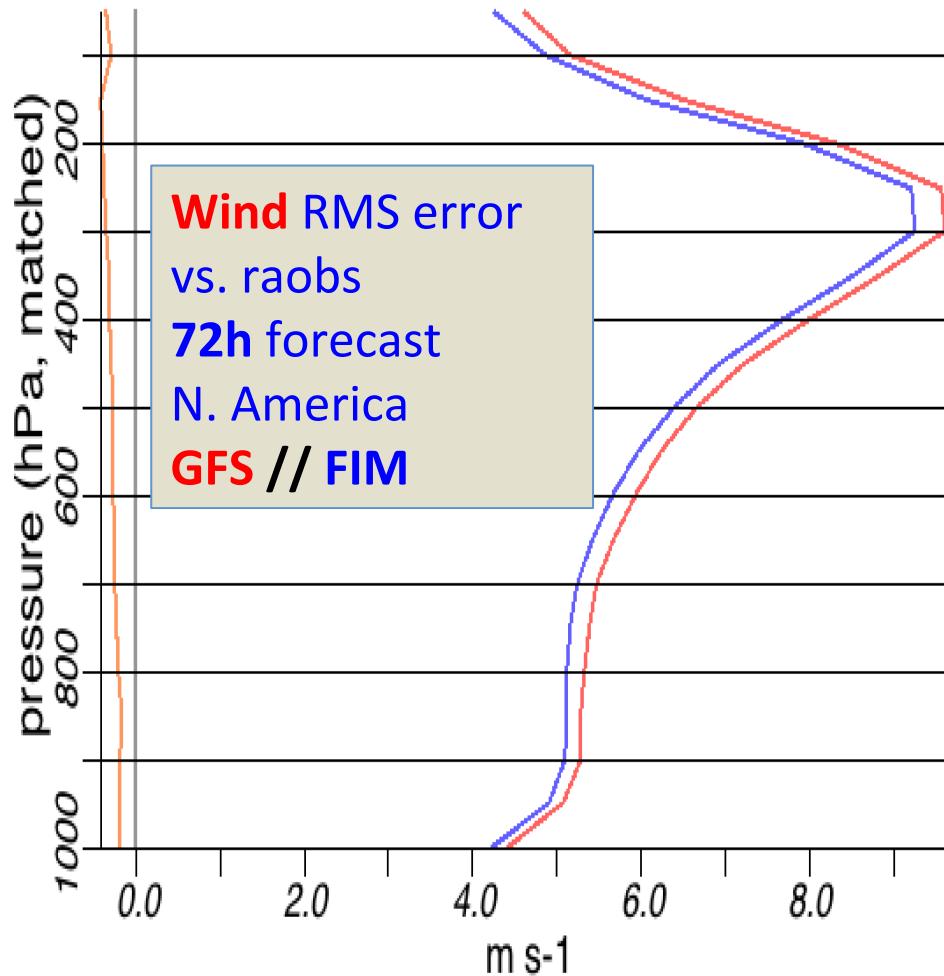
- ZERO rgn:RR, winds rms 72h
- FIMRETRO_r3162_pop-GFS rgn:RR, winds rms 72h fcst
- FIMRETRO_r3162_pop rgn:RR, winds rms 72h fcst 2012-06-04 thru 20
- GFS rgn:RR, winds rms 72h fcst 2012-06-04 thru 2013-05-30
- ZERO rgn:RR, winds rms 120h fcst
- FIMRETRO_r3162_pop-GFS rgn:RR, winds rms 120h fcst 2012-06-06 thru 20
- FIMRETRO_r3162_pop rgn:RR, winds rms 120h fcst 2012-06-06 thru 20
- GFS rgn:RR, winds rms 120h fcst 2012-06-06 thru 2013-05-30



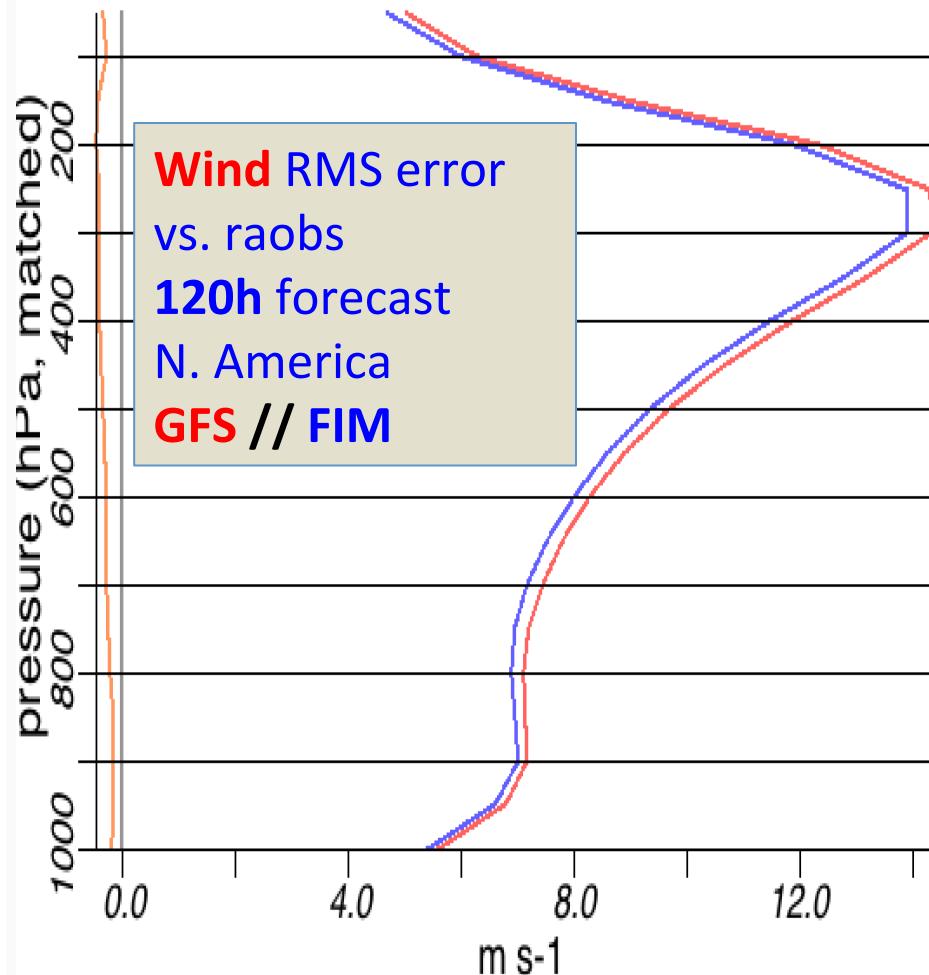
RMS errors (smaller better) - verification with rawinsonde observations

More recent 7+month period – June 2013 through January 2014

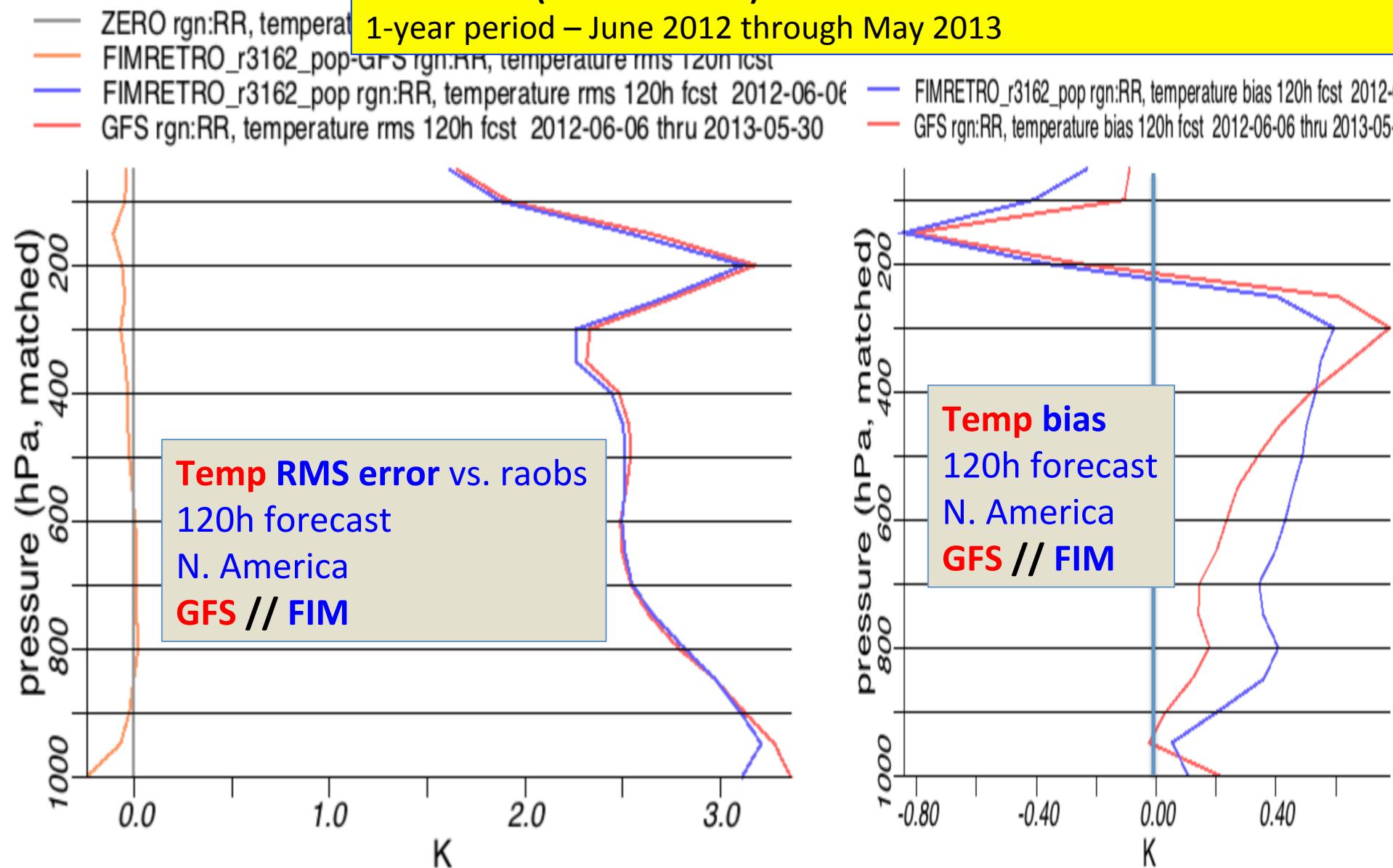
- ZERO rgn:RR, winds rms 72h
- FIM-GFS rgn:RR, winds rms 72h fcst
- FIM rgn:RR, winds rms 72h fcst 2013-06-01 thru 2014-01-12
- GFS rgn:RR, winds rms 72h fcst 2013-06-01 thru 2014-01-12



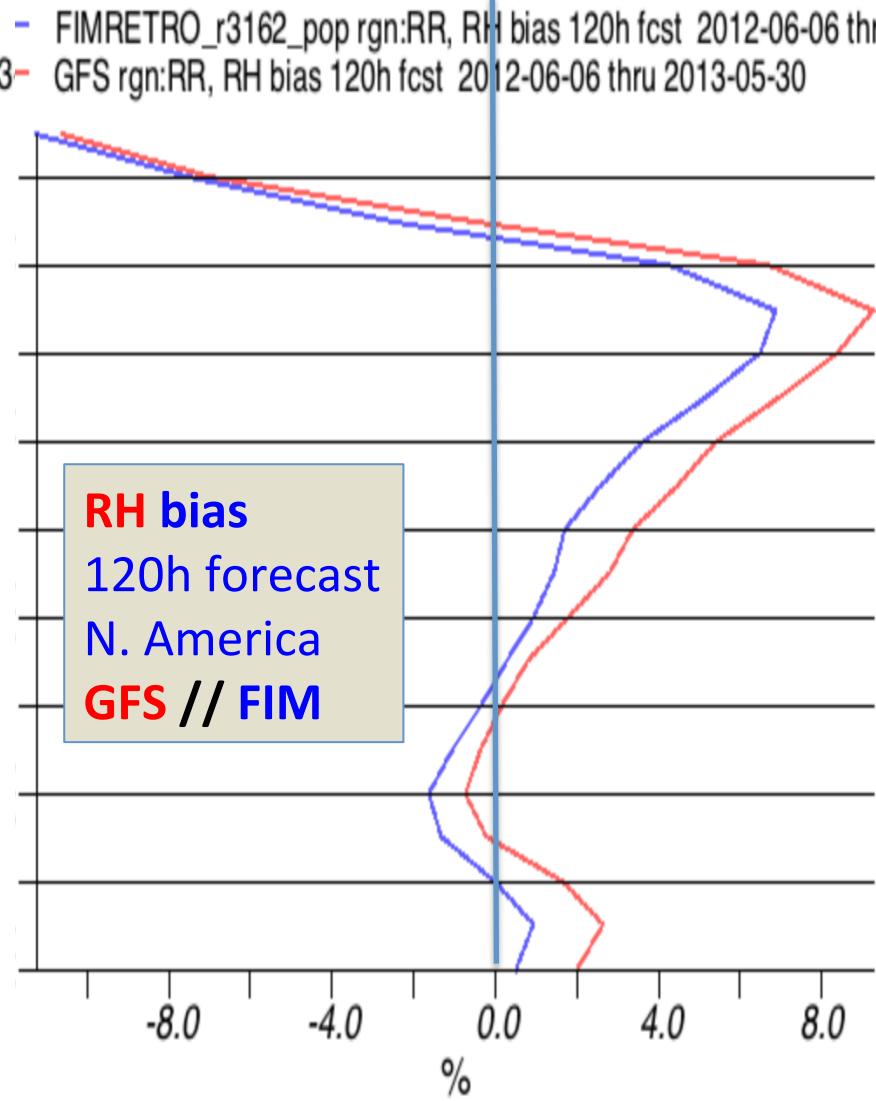
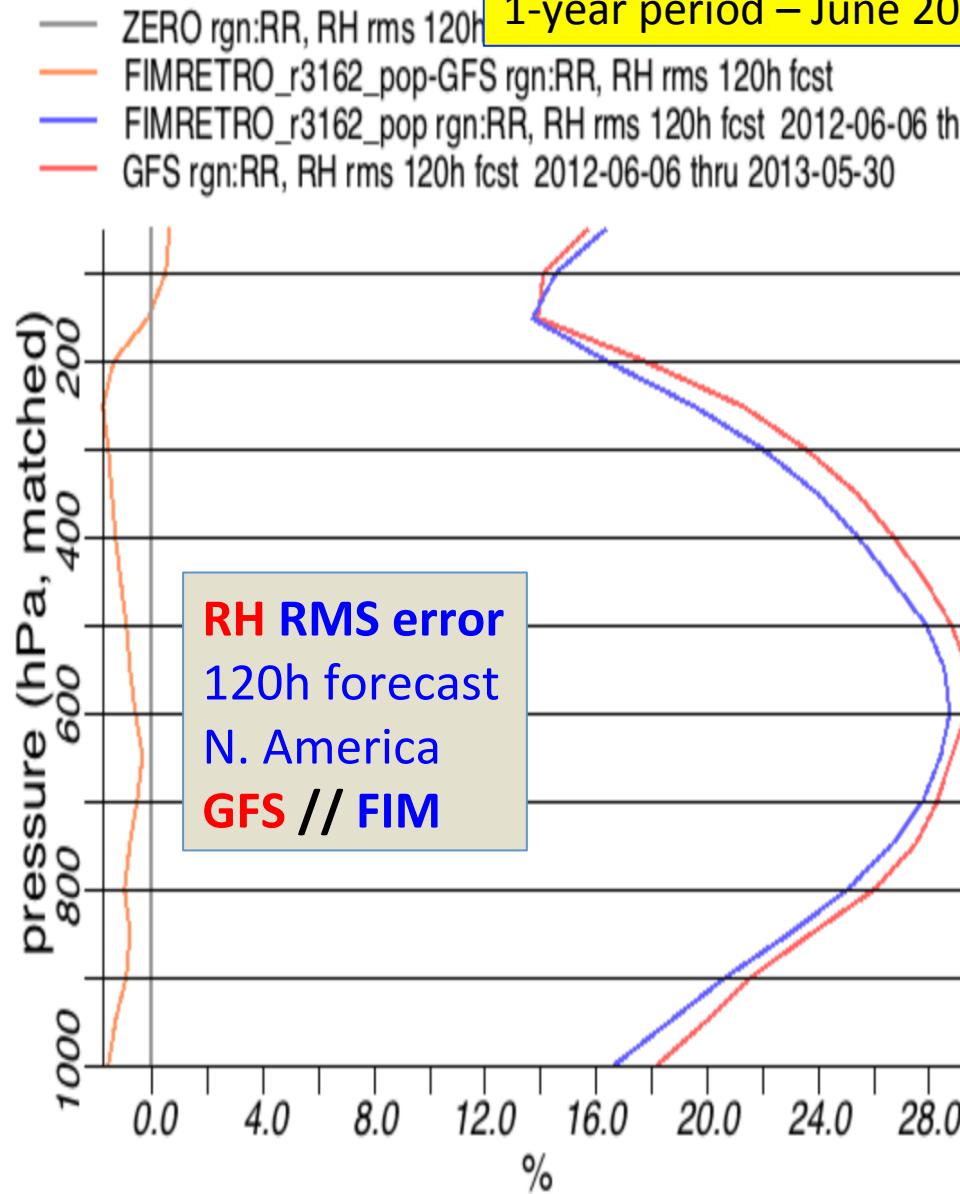
- ZERO rgn:RR, winds rms 120h fcst
- FIM-GFS rgn:RR, winds rms 120h fcst
- FIM rgn:RR, winds rms 120h fcst 2013-06-01 thru 2014-01-12
- GFS rgn:RR, winds rms 120h fcst 2013-06-01 thru 2014-01-12

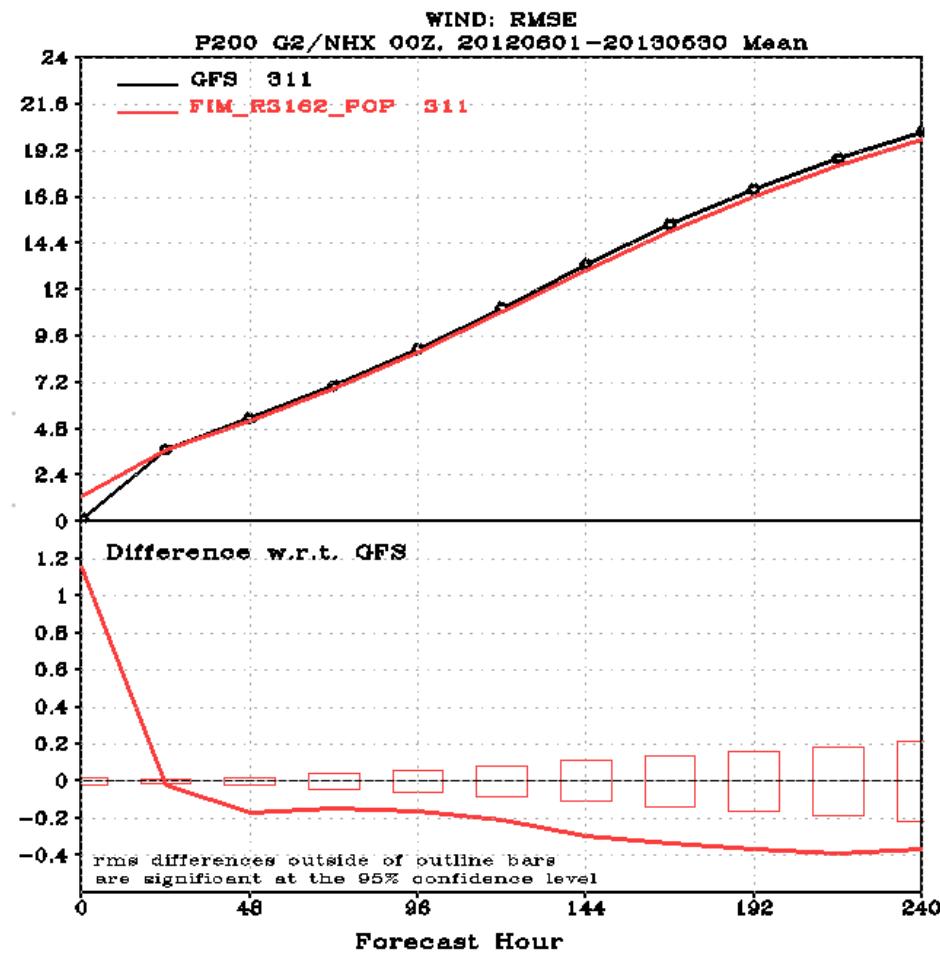
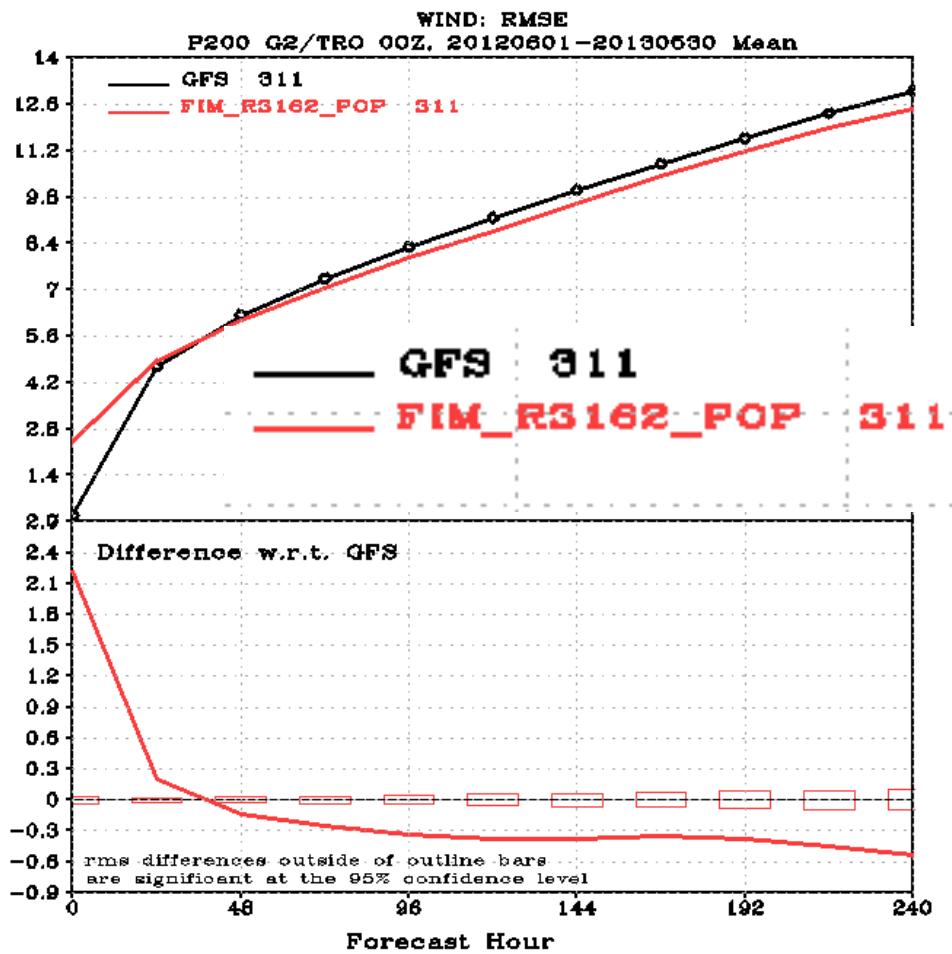


RMS errors (smaller better) - verification with rawinsonde observations
1-year period – June 2012 through May 2013



RMS errors (smaller better) - verification with rawinsonde observations
1-year period – June 2012 through May 2013

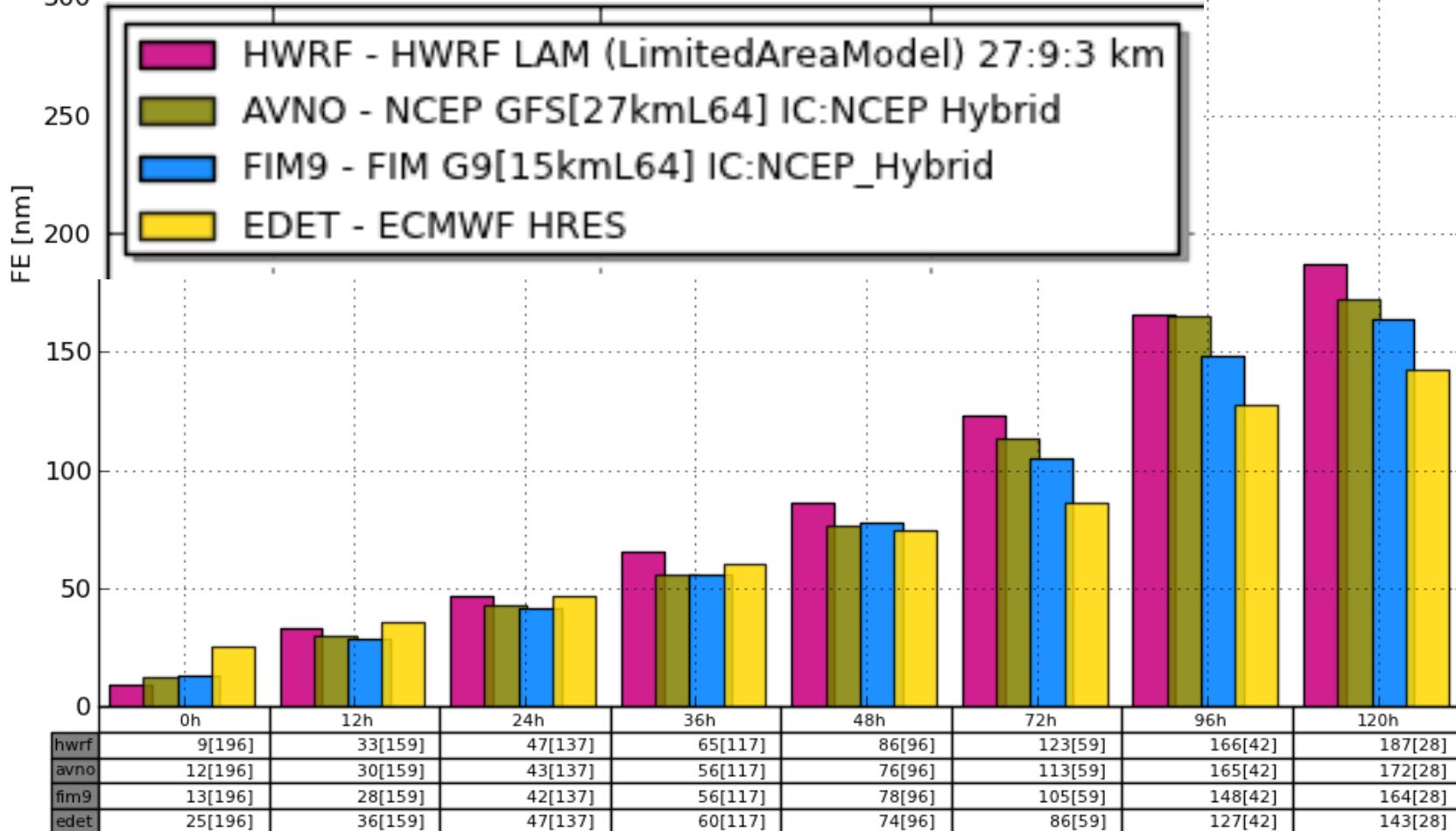




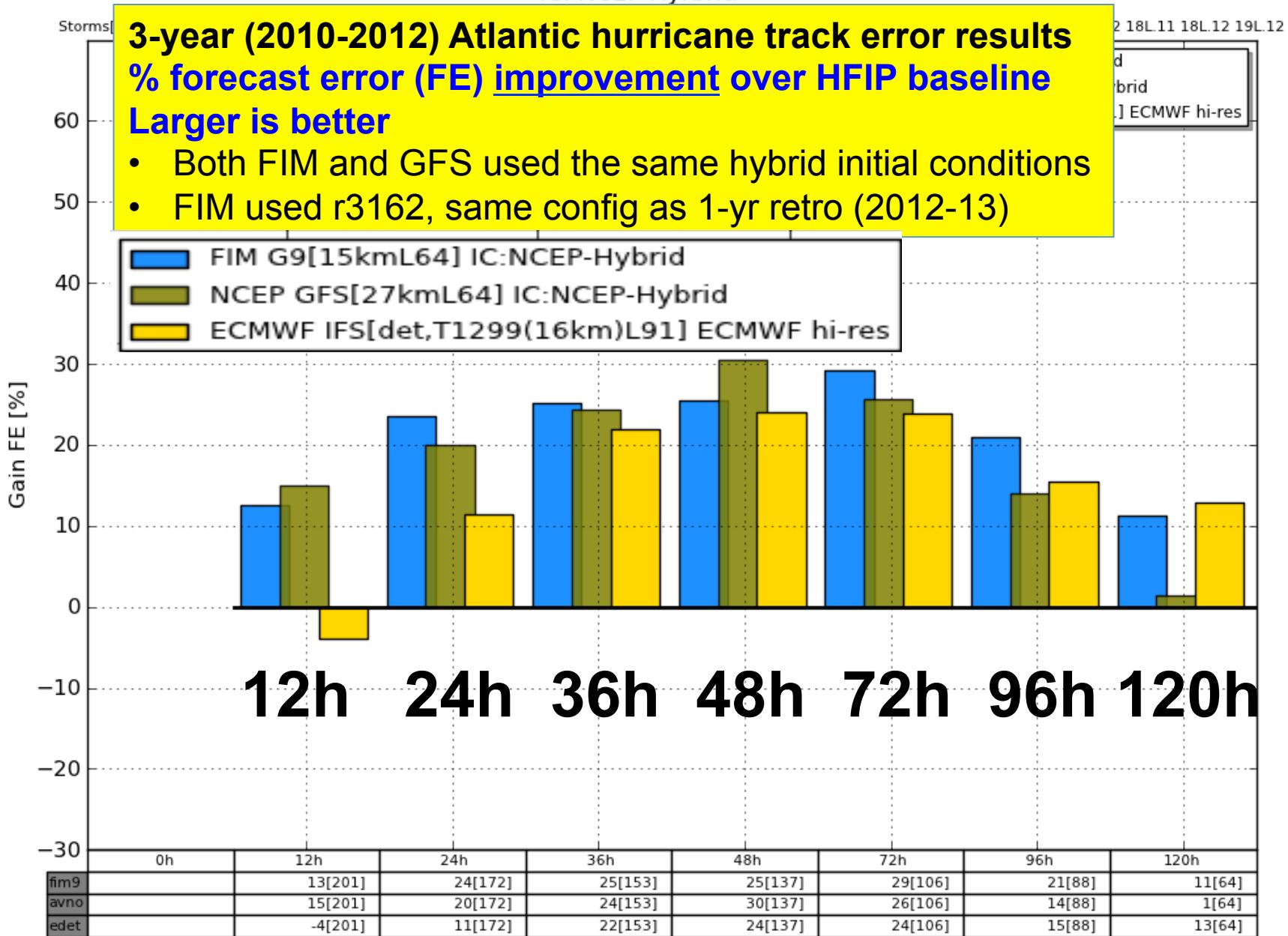
200 hPa wind forecasts in tropics
Results from new retro
June 2012 through May 2013

Storms[N] [26]: 01L.13 02E.13 02L.13 03E.13 03L.13 04E.13 04L.13 05E.13 05L.13 06E.13 ... 10L.13 11E.13 11L.13 12L.13 13E.13 13L.13 14E.13 15E.13 16E.13 17E.13

TC track error - 2013 hurricanes – Atlantic and E. Pacific basins combined (Smaller is better)



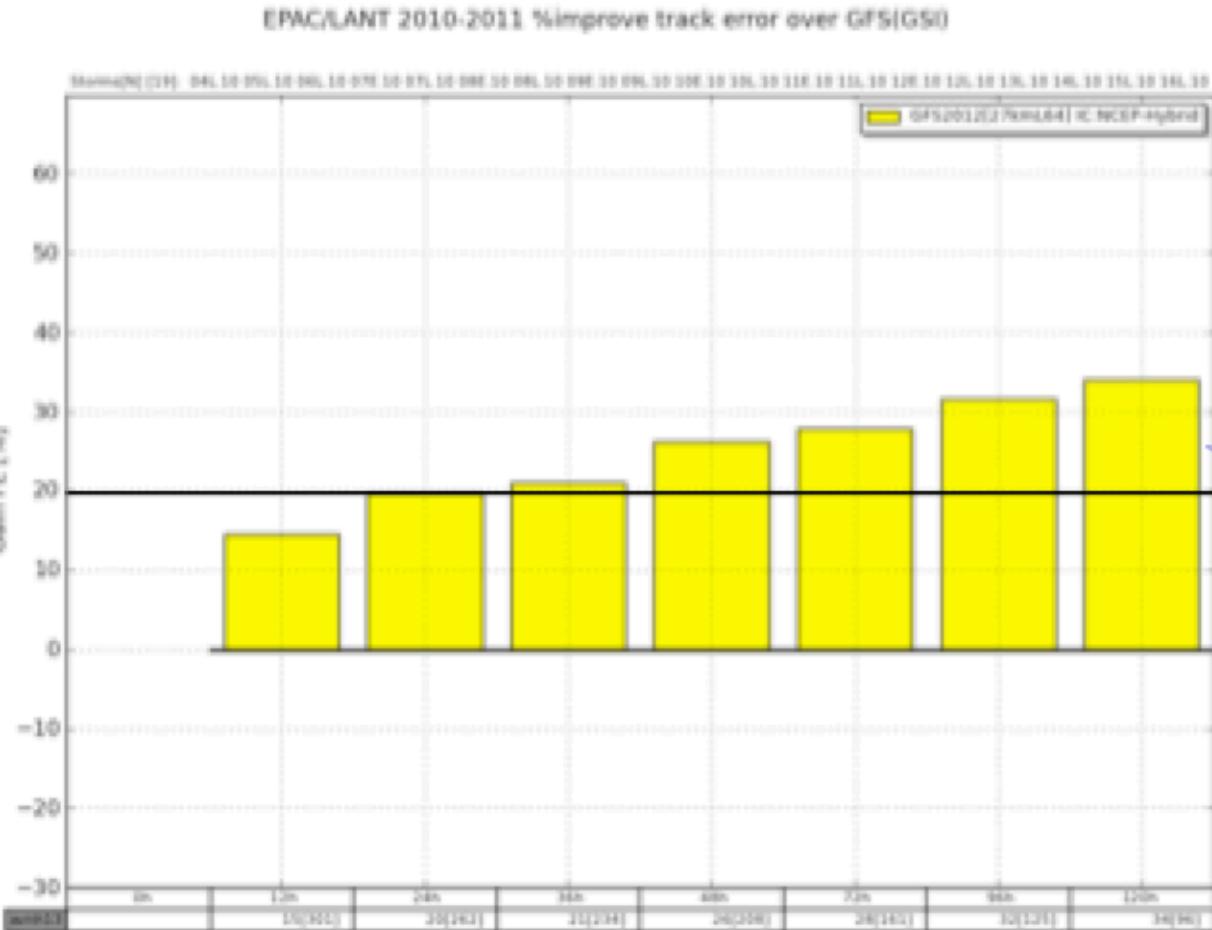
LANT 2010-2012 FIM9 v GFS v ECMWF track error %improvement over HFIP baseline
IC: NCEP-Hybrid



FIM9: 2010-12 retro runs for HFIP 2013 demo

slide - 2

impact of hybrid GFS-EnKF on GFS – % improvement of GFS2012 GSI v hybrid GFS-EnKF



reaches 20% improvement (HFIP goal) at D+1 and > 30% at D+5

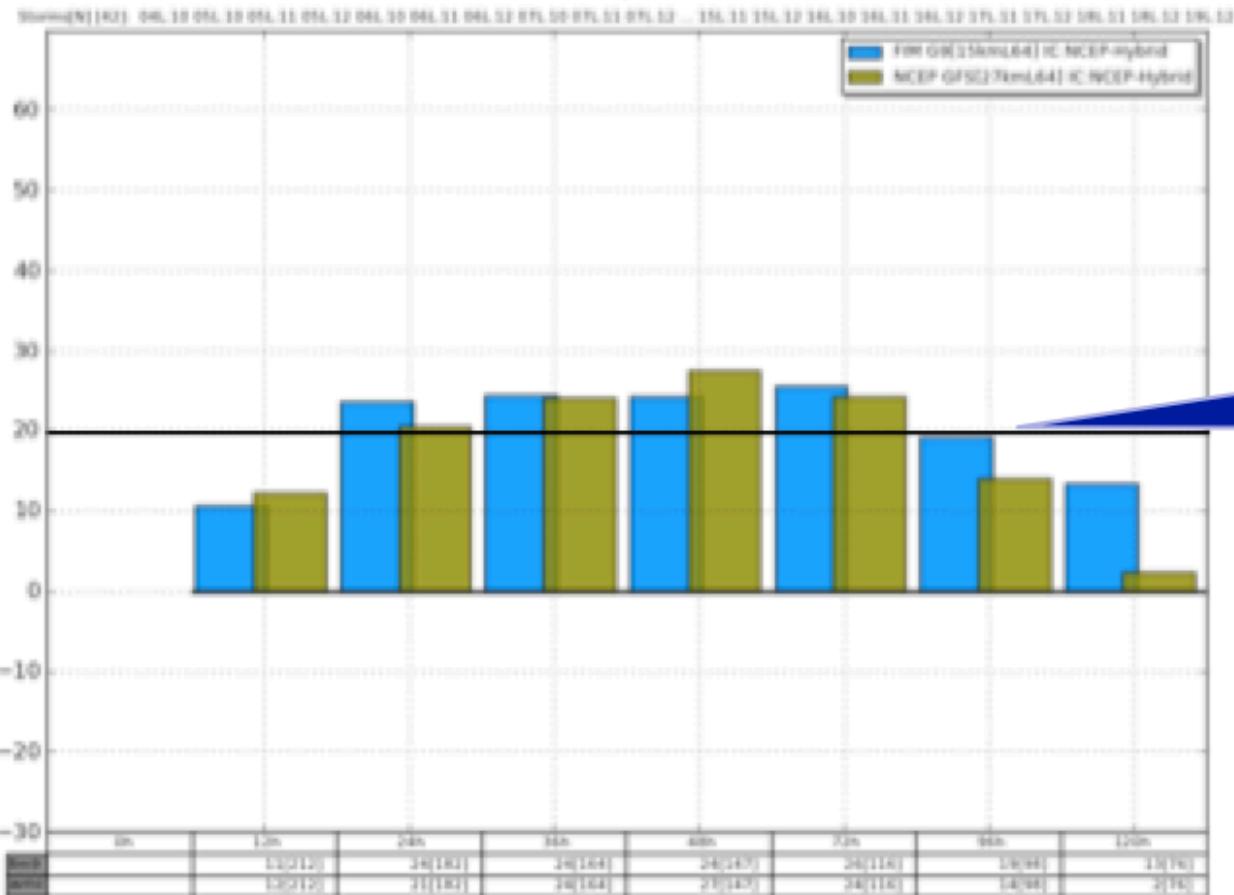


FIM9: 2010-12 retro runs for HFIP 2013 demo

slide - 3

FIM9 2013 v GFS 2012 – % improvement over HFIP baseline in the atlANTic

LANT 2010-2012 FIM9 v GFS track error %improvement over HFIP baseline
IC: NCEP-Hybrid



exceeds HFIP improvement goal of 20% between D+1 and D+3



FIM changes since Apr 2012-Apr 2013

- Interpolation of initial conditions improved
 - Vertical: Temperature, height – now in Exner instead of pres
 - Horizontal: Winds interpolation improved near poles
- Interpolation of output –
 - improved to vector interpolation near poles
- Model itself
 - Horizontal smoothing of hybrid isentropic-sigma vertical coordinate – reduced by factor of 3
 - Vertical regridding from isentropic coordinate - now limited to 1 Δs per time step

Also tested but not improving skill yet

- 4th order momentum diffusion
- Janjic horizontal pressure gradient

In progress

- Testing of GSI/hybrid/ensemble assimilation with FIM (increment interpolation from FIM to GFS grid)
- Testing of multi-model ensemble with GFS – HFIP (real-time) and GEFS (retrospective) applications

FIM changes for 2014

- Numerics/grid
 - More accurate interpolation for edge momentum values
 - More regular icosahedral grid
 - Hybrid vertical coordinate – limit regridding to 1dz
- Post-processing
 - Icos-grid smoothing by variable
 - Output of 1/8 grid data including for track/intensity TC forecasts

Areas of ongoing work but not yet in April-2014 real-time FIM for HFIP

- Physics
 - May 2012 GFS physics implementation
 - Grell-Freitas (2013, ACPD) physics - scale-aware, aerosol-aware cumulus (deep/shallow)
 - Stochastic versions for GFS physics (with HIWPP)
- Data assimilation
 - Complete development of ensemble DA with FIM/GSI following GFS EnKF/ hybrid